

Teaching Statistics to Psychology Students using Reproducible Computing package RC and supporting Peer Review Framework

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- Up to 11% of published psychology research articles contain 1 or more statistical errors.

GAISE*

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* Guidelines for Assessment and Instruction in Statistics Education

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 - Use technology for developing conceptual understanding and analyzing data
 - Use assessments to improve and evaluate student learning

Garfield et al. (2002) “First Courses in Statistical Science:
The Status of Educational Reform Efforts”

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- “It is one thing to state that statistical thinking and reasoning should be the focus of a course, or should be the desired course outcomes. It is another matter entirely to achieve this...”
- “ We believe that appropriate content, a focus on data analysis and real problems, and careful use of high quality technological tools will help students better achieve the suggested course goals and outcomes.”



Enhancing Stats Education with New Technology '80s Style

The Classroom Calculator

Finally, a front-of-the-room calculator that lets students observe both the keystroke sequence and displayed answer.

Model 30
\$1,495

Other popular
models
available.



Easily viewable from
up to 60 feet.

Watch student
enthusiasm grow as
you use The
Classroom Calculator!

The Classroom Calculator puts an end to dull blackboard listings and allows students to see the logic of each step in a calculation.

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Weight: Approximately 6 lbs.
Power: 110 Volt AC
Mounting strip included.

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1700 Duncan Avenue
Technology Park
Hubbell, MI 49934
(906) 487-2494

Complete documentation included with each unit.

The Reform of [Statistics] Pedagogy

- **Goals:**
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- **What helps learning:**
 - Group work in and out of class; explaining and communicating; frequent rapid feedback; work on problem formulation and open-ended problems.

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 - emphasise graphical concepts and automate calculation
 - foster active learning
 - because “the most effective learning takes place when content (what we want students to learn), pedagogy (what we do to help them learn), and technology reinforce each other in a balanced manner.” (Moore, 1997).

A new approach to statistics Education

- Within the pedagogical paradigm of (social) constructivism permitting:
 - Interaction & collaboration via peer review.
 - Experimentation.

A new approach to statistics Education

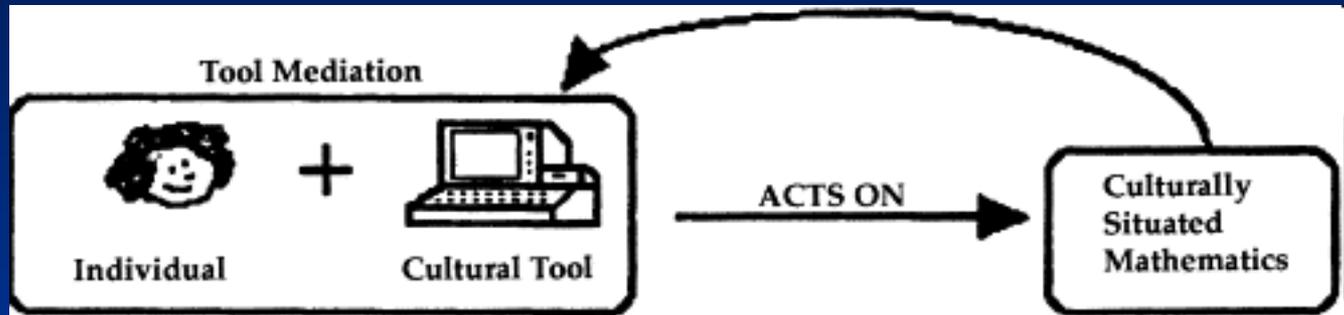
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- www.FreeStatistics.org

Constructivism

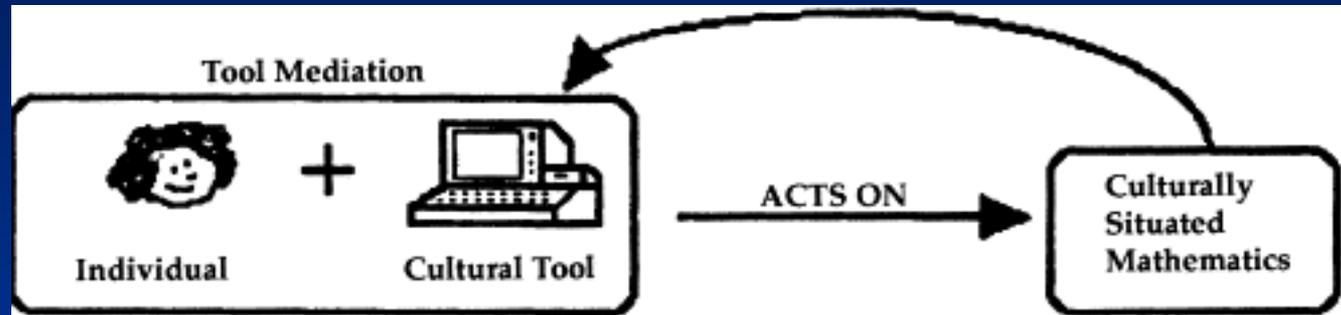
Social



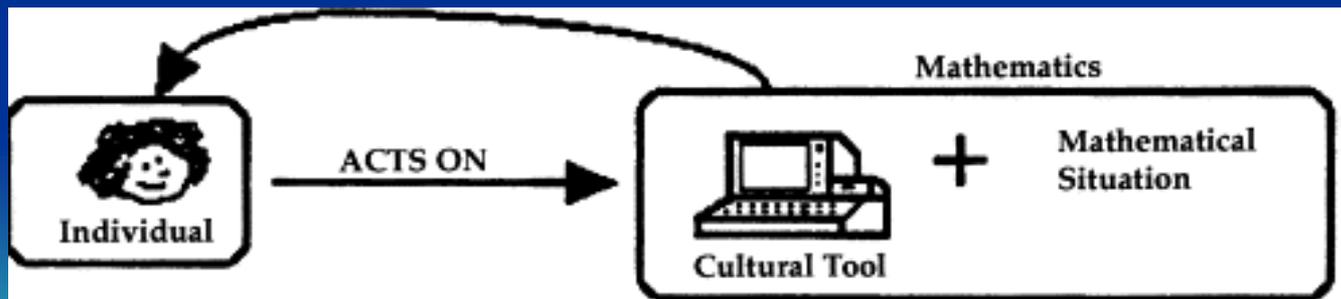
Smith, 1998

Constructivism

Social



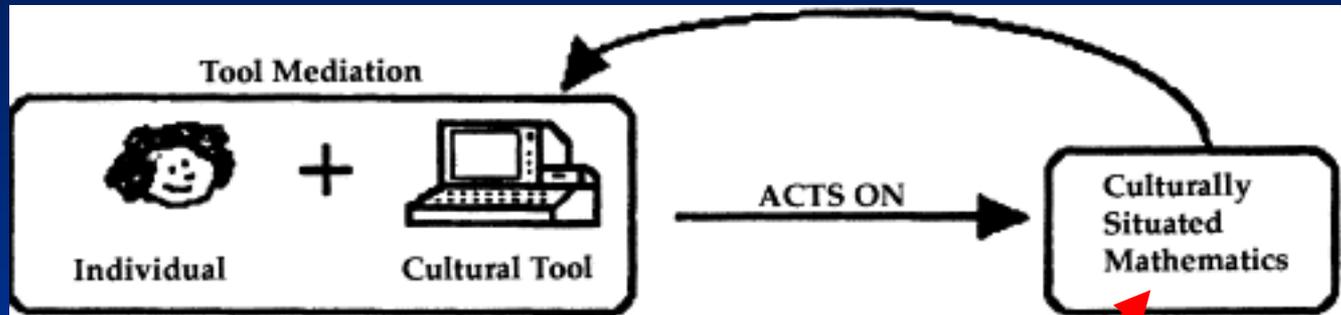
Individual



Smith, 1998

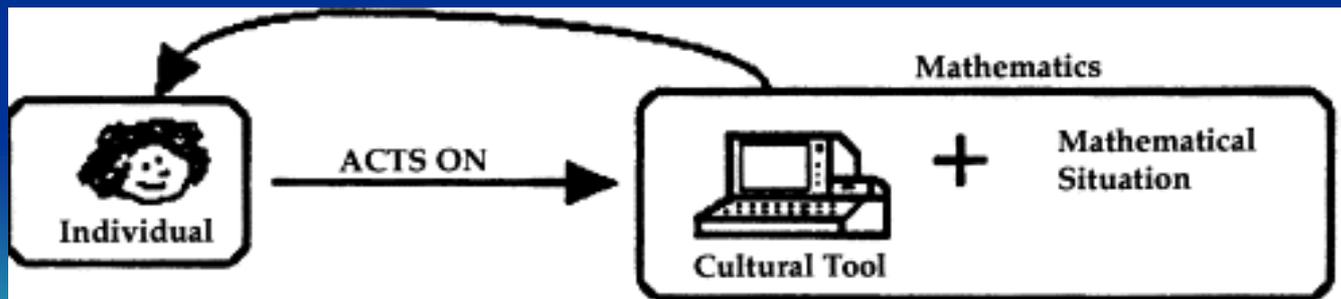
Constructivism

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Data Sharing and Peer reviewing via compendiums

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Smith, 1998

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- Documents that allow us to preserve, reproduce, and re-use the results of data analysis.



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 - Analysis can be studied and checked by other researchers.
 - New compendiums can be created to communicate new findings.



'Classical' vs. RC Compendium

- 'classical' compendium
 - Typically a zip file with
 - data files
 - R scripts
 - Sweave documents ...



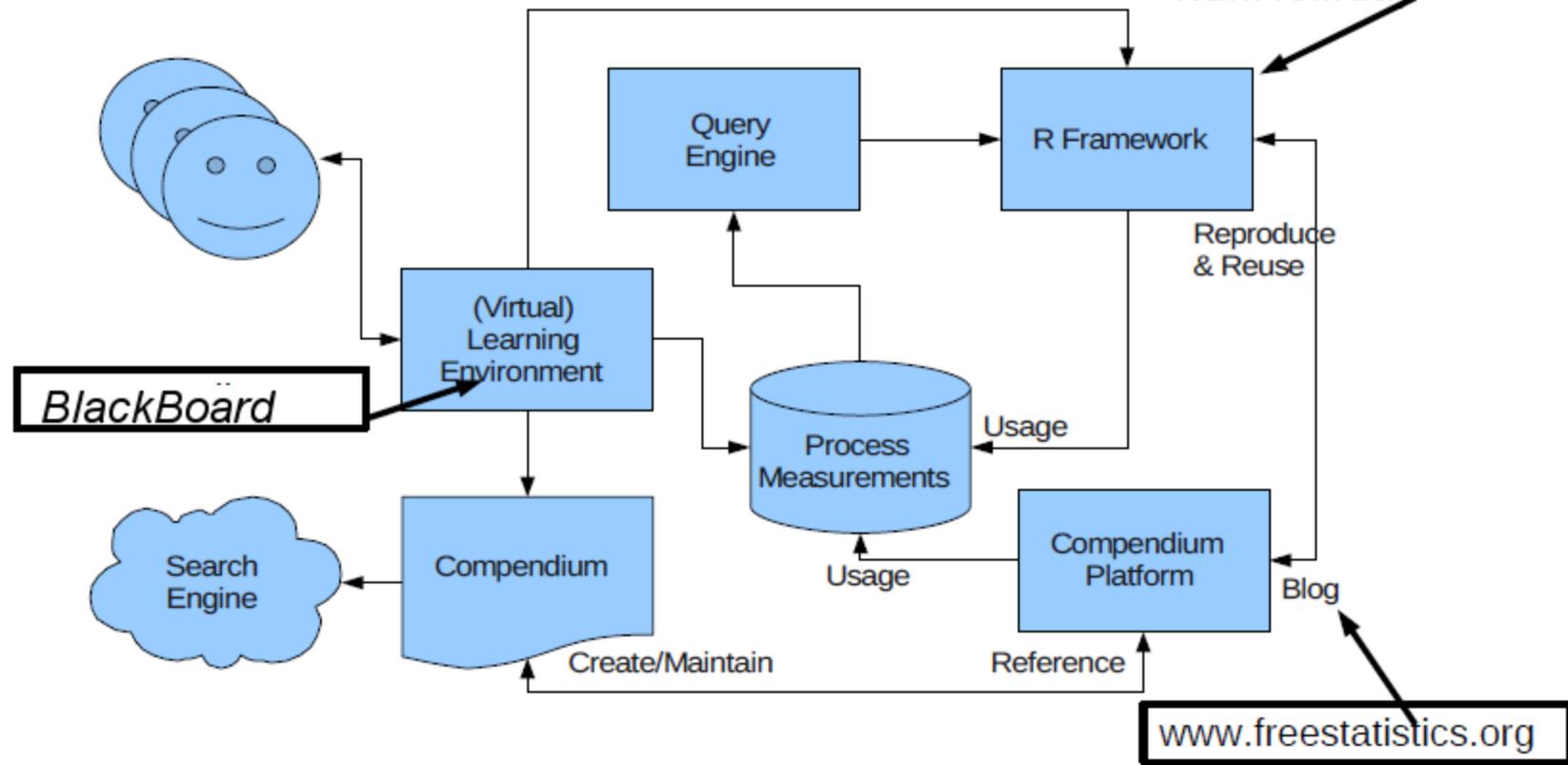
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- RC compendium
 - Simple document form (ODF, PDF, .doc..)
 - Containing links to remotely stored computations.
 - Accessed via any browser



Learning System or Educational Laboratory?

*WWW.wessa.net
/lanHolliday*



Features of the Compendium Platform

- Any computation that is created within the R Framework can be easily archived in the repository
 - there is no need for students to keep track of the data, the model parameters, or the underlying statistical software code;

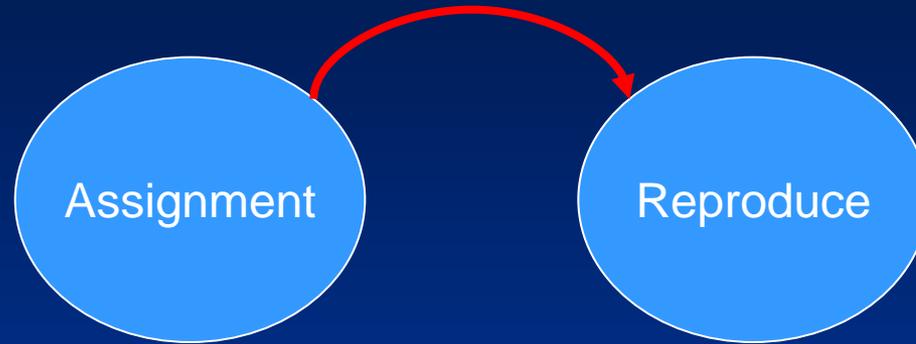
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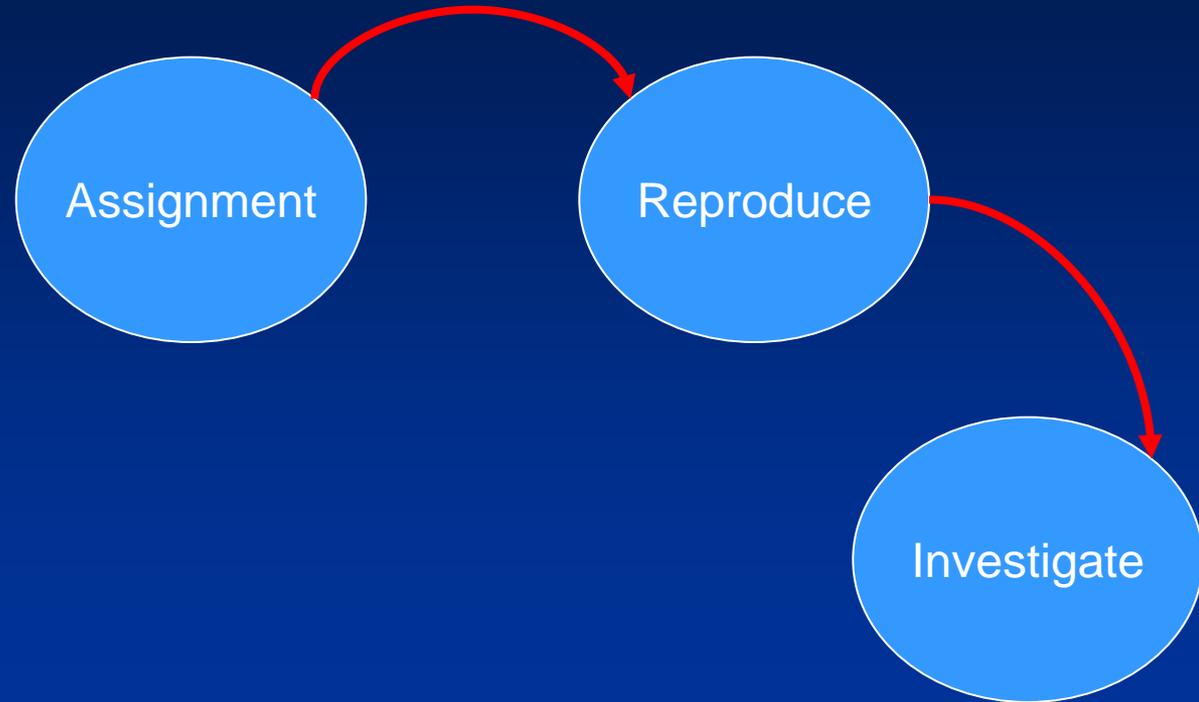
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- Educators and researchers are able to retrieve data for research purposes.

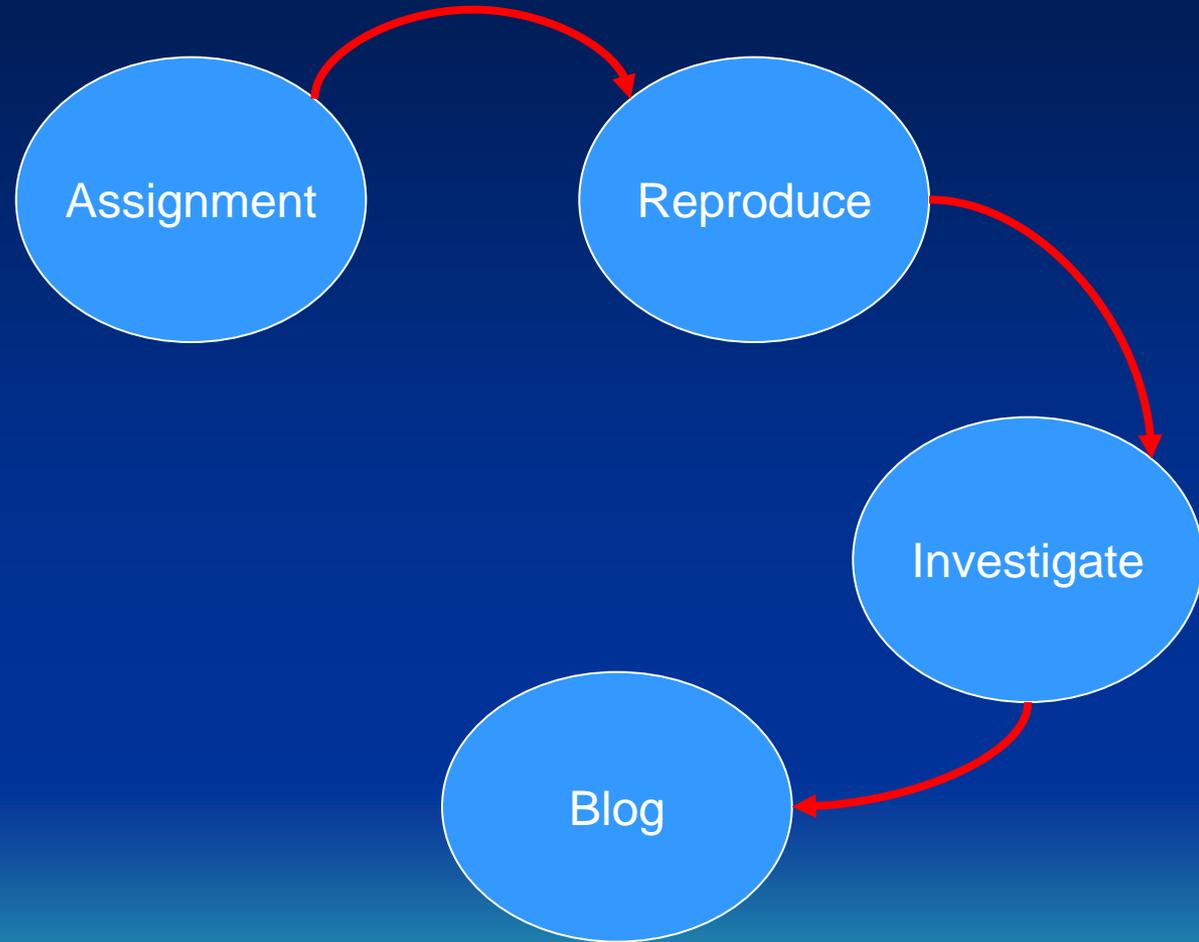
What Students Do.



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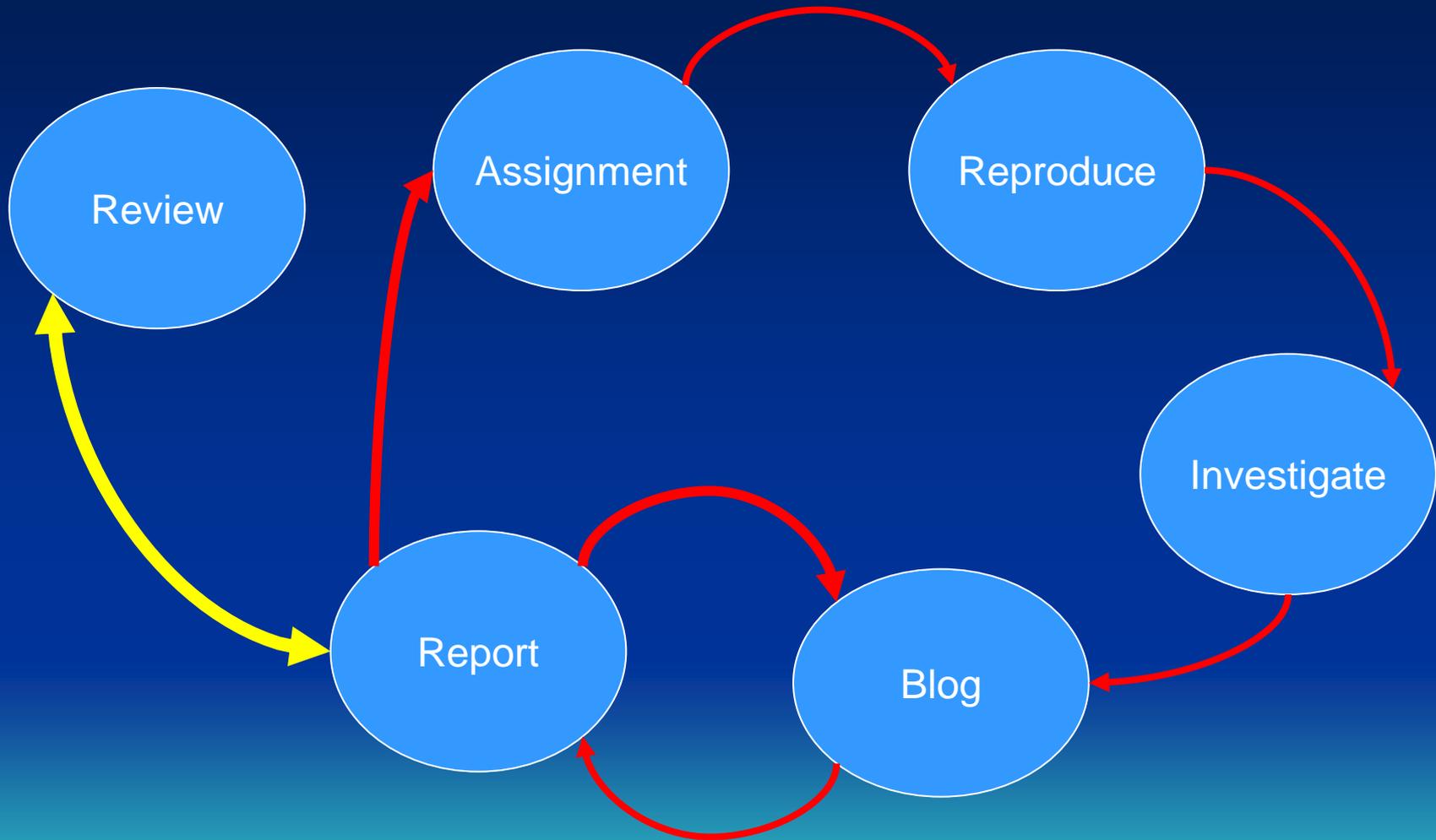
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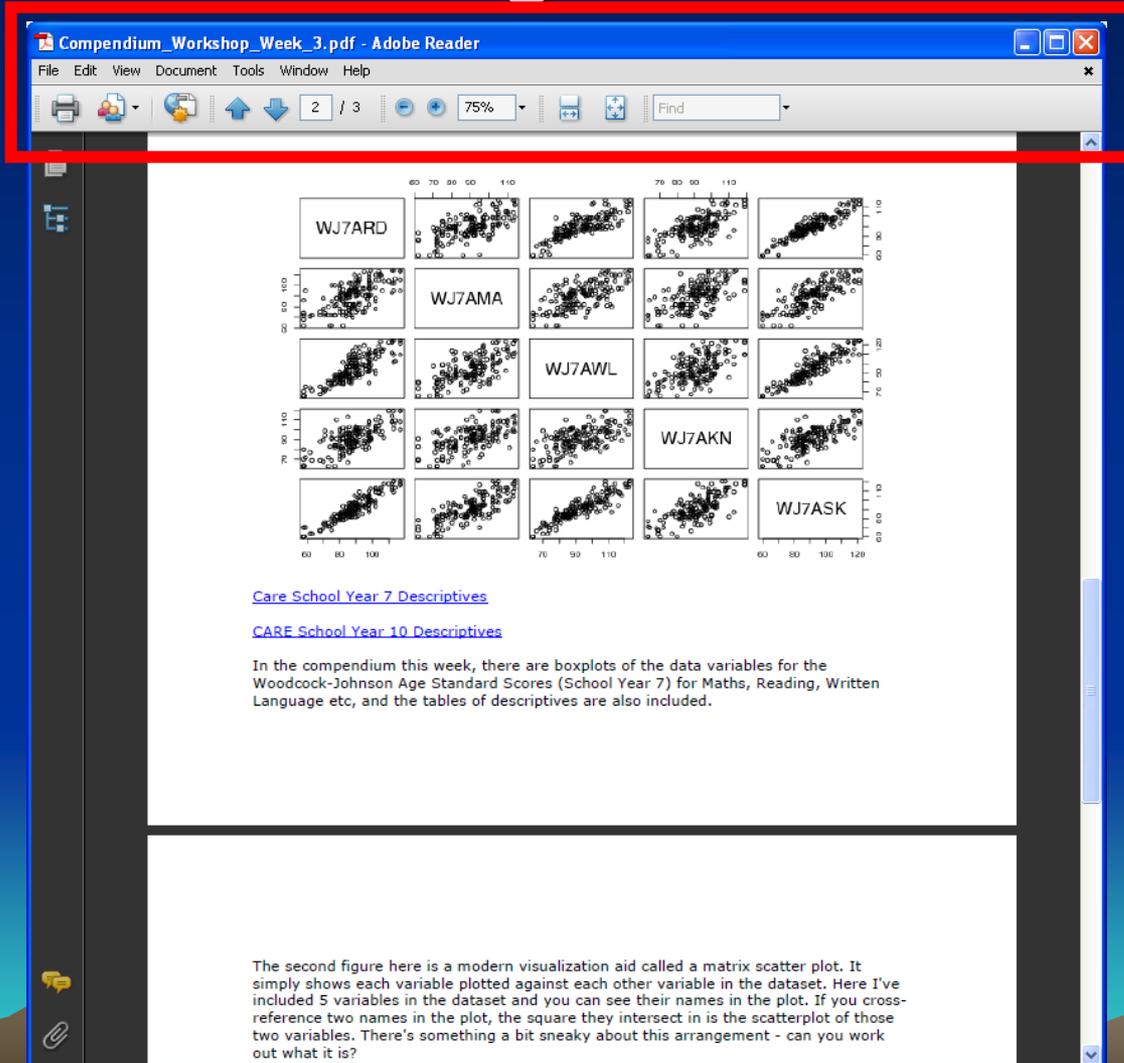
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What Students Do.



Snapshot of a Workshop Assignment Compendium



- Produced in a normal word processor (here I've made a PDF).

<http://www.freestatistics.org/blog/index.php?v=date/2009/Oct/26/t1256547982lxacofnhraf7g7w.htm/>

Snapshot of a Workshop Assignment Compendium

Compendium_Workshop_Week_3.pdf - Adobe Reader

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2 / 3 75% Find

WJ7ARD WJ7AMA WJ7AWL WJ7AKN WJ7ASK

[Care School Year 7 Descriptives](#)

[CARE School Year 10 Descriptives](#)

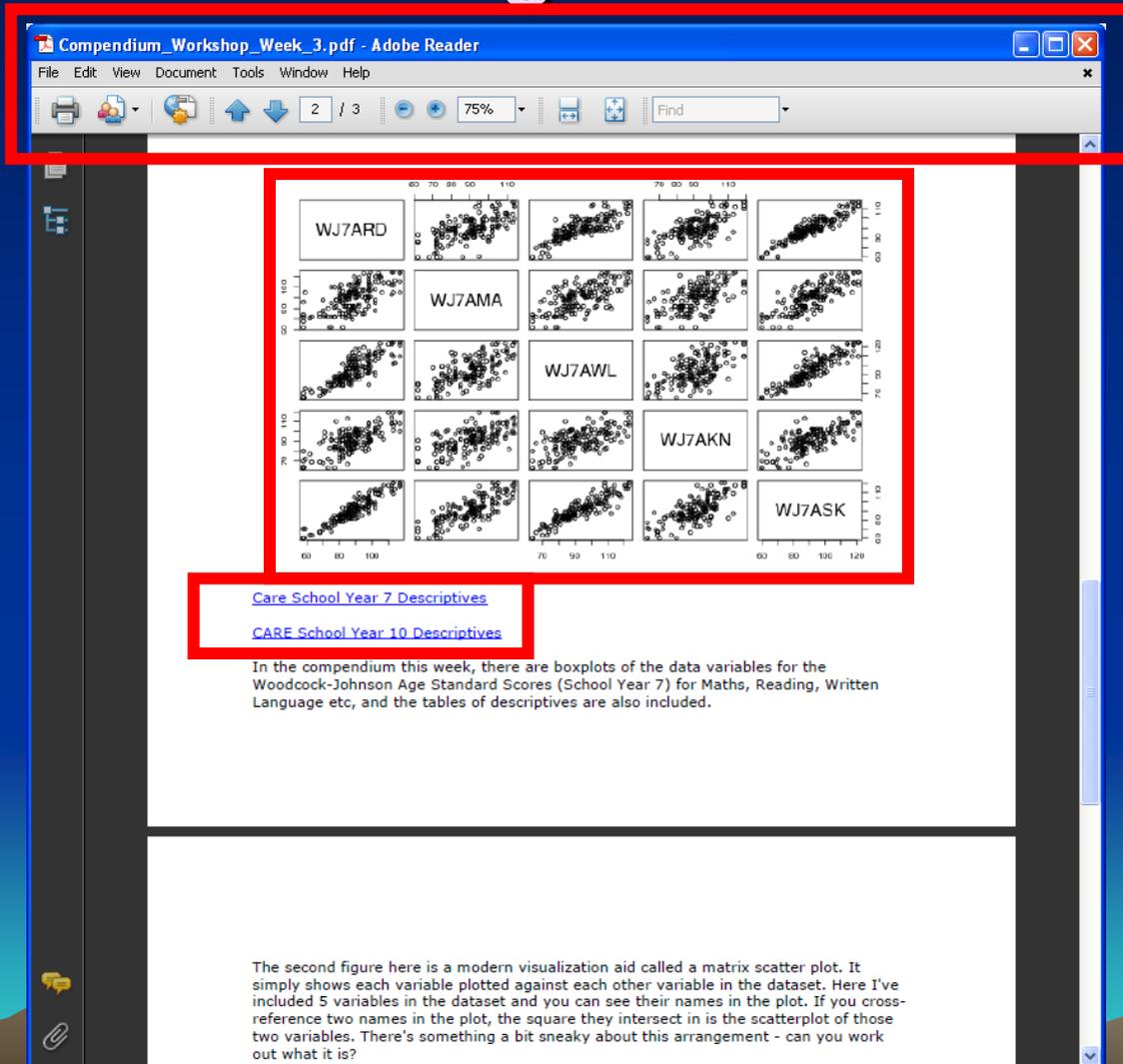
In the compendium this week, there are boxplots of the data variables for the Woodcock-Johnson Age Standard Scores (School Year 7) for Maths, Reading, Written Language etc, and the tables of descriptives are also included.

The second figure here is a modern visualization aid called a matrix scatter plot. It simply shows each variable plotted against each other variable in the dataset. Here I've included 5 variables in the dataset and you can see their names in the plot. If you cross-reference two names in the plot, the square they intersect in is the scatterplot of those two variables. There's something a bit sneaky about this arrangement - can you work out what it is?

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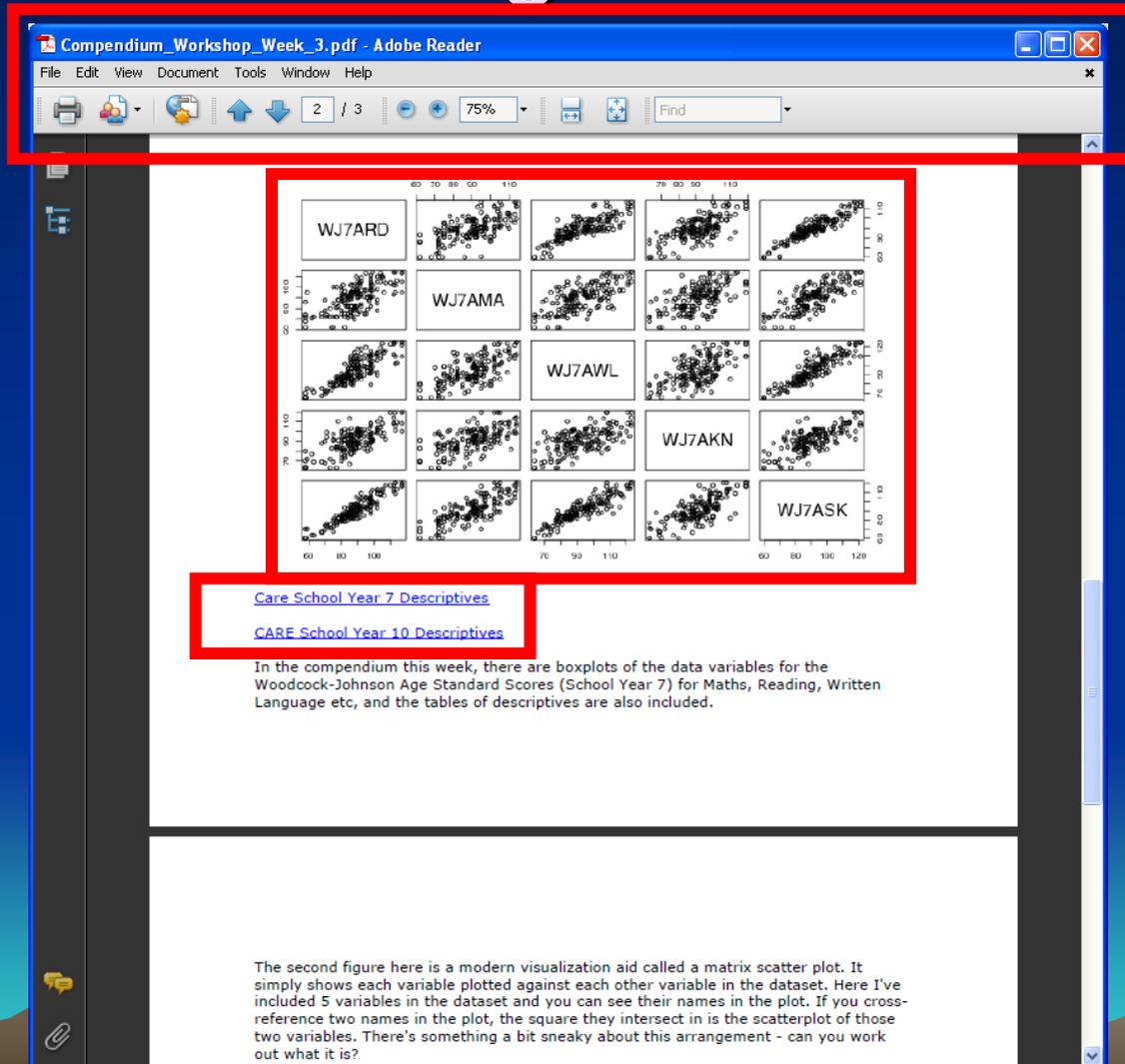
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Care Age 10 Data

The author of this computation has been verified

R Software Module: [Ian.Holliday/rwasp_CARE_Data_Boxplot.wasp](#) (opens new window with default values)

Title produced by software: Boxplot and Trimmed Means

Date of computation: Mon, 26 Oct 2009 03:01:50 -0600

Cite this page as follows:

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  year = {2010},
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- Unique blog URL to Reproducible Content

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- Citeable work – also for students!

CARE Data - Boxplot and trimmed Means - Free Statistics and Forecasting Software (Calculators) v.1.1.23-r4 - Mozilla Firefox

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:: Boxplot and Trimmed Means - Free Statistics Software (Calculator) ::

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All rights reserved. The non-commercial (academic) use of this software is free of charge. The only thing that is asked in return is to [cite this software](#) when results are used in publications.

This free online software (calculator) computes a BoxPlot a matrix observations by row and variables by column. This R module is used in Workshop 2 of the PY2224 statistics course at Aston University, UK. The data vectors were abstracted from the study dataset Bibliographic Citation: Ramey, Craig T., James J. Gallagher, Frances A. Campbell, Barbara H. Wasik, and Joseph J. Sparling. CAROLINA ABECEDARIAN PROJECT AND THE CAROLINA APPROACH TO RESPONSIVE EDUCATION (CARE), 1972-1992 [Computer file]. ICPSR version. Chapel Hill, NC: University of North Carolina [producer], 2002. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2004.

Enter (or paste) a matrix (table) containing all data (time) series. Every column represents a different variable and must be delimited by a space or Tab. Every row represents a period in time (or category) and must be delimited by hard returns. The easiest way to enter data is to copy and paste a block of spreadsheet cells. Please, do not use commas or spaces to separate groups of digits!

Send output to:

Browser Blue - Charts White

Data X:

88	95	95	81	84
98	92	87	90	97
89	95	91	91	88
81	97	84	87	87
88	92	92	89	92
95	104	84	85	91
79	79	84	81	80
91	78	69	80	73
80	79	84	75	73
91	86	84	84	77
85	92	85	91	86
94	78	89	87	82
86	86	83	90	82
82	71	86	72	73
107	90	91	96	99
97	93	90	88	90

Names of X columns:

WJ10AFS WJ10AVA WJ10ARD WJ10AMA WJ10AKN

Sample Range:
(leave blank to include all observations)

From:

[Select module]

Load Module

- Home Page
- Equation Plotter
- Time Series Analysis (new)
- Time Series Analysis (old)
- Multiple Regression (new)
- Multiple Regression (old)
- Descriptive Statistics
- Statistical Distributions
- Hypothesis Testing
- Statistics Education

- Academic citations
- Computations Archive
- Search Computations
- R Project
- FAQ
- About Wessa.net

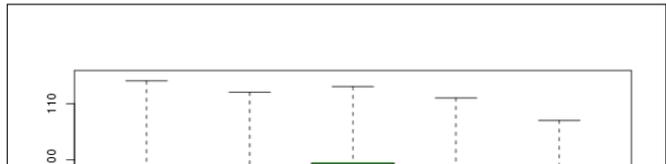
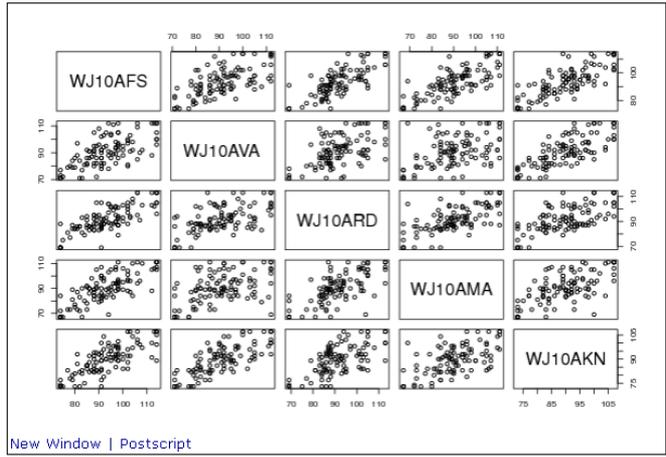
Data for the reproduced computations

Can paste in data for new analysis e.g. from excel

WJ10AKN	73	83	90	96	107
---------	----	----	----	----	-----

Boxplot Notches			
Variable	lower bound	median	upper bound
WJ10AFS	89.99	92	94.01
WJ10AVA	88.6	91	93.4
WJ10ARD	87.91	90	92.09
WJ10AMA	87.83	90	92.17
WJ10AKN	87.98	90	92.02

Boxplot Means		
Variable	trimmed mean	unbiased SD
WJ10AFS	93.09	10.45
WJ10AVA	90.72	11.14
WJ10ARD	91.53	10.4
WJ10AMA	90.35	11.84
WJ10AKN	89.76	9.22

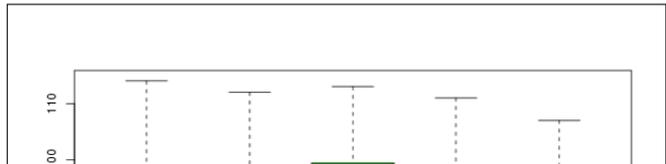
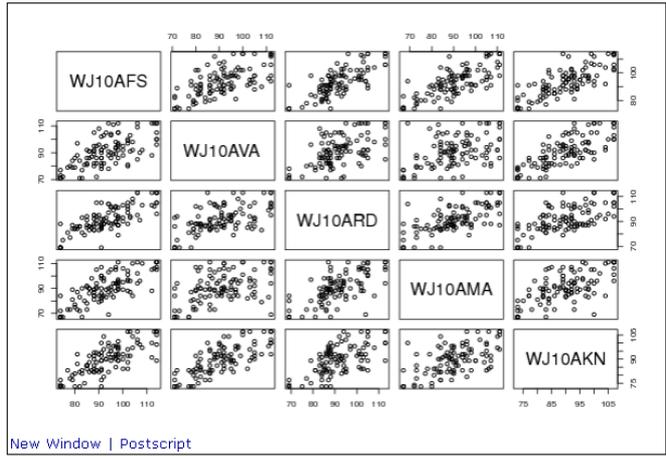


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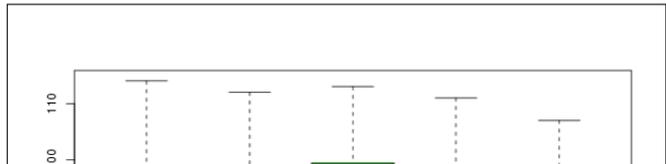
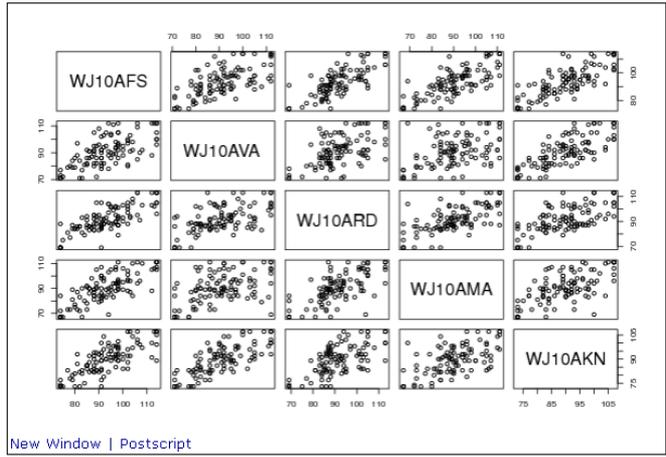


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- Computation is recomputed externally by wessa.net R servers.
- Enables modification and exploration using controls on the page.

CARE Data - Boxplot and Timmed Means - Free Statistics and Forecasting Software (Calculators) v.1.1.23-r4 - Mozilla Firefox

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https://www.wessa.net/Ian.Holliday/rwasp_CARE Data Boxplot.wasp

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Chart options

Width:	600
Height:	400
Title:	CARE AGE 7 DATA
Label y-axis:	Test Scores
Label x-axis:	CARE Variable Names

R Code

```
#'GNU S' R Code compiled by R2WASP v. 1.0.44 ()
#Author: Dr. Ian E. Holliday
#To cite this work: Ian E. Holliday, 2009, CARE BoxPlot
and Descriptives (v1.0.1) in Free Statistics Software
(v$_version), Office for Research Development and
Education, URL http://www.wessa.net/Ian.Holliday
/rwasp_varia1.wasp/
#Source of accompanying publication:
#Technical description:
par1 <- as.numeric(par1) #colour
par2<- as.logical(par2) # Notches ?
par3<-as.numeric(par3) # % trim
if(par3>45){par3<-45;warning('trim limited to 45%')}
if(par3<0){par3<-0;warning('negative trim makes no
sense. Trim is zero.')}
lotrm<-as.integer(length(y[,,])*par3/100)+1
hitrm<-as.integer(length(y[,,])*par3/100)
y1<-array(dim=c(dim(y)[1], hitrm-lotrm+1),
dimnames=list(dimnames(y)[[1]], 1:(hitrm-lotrm+1) ))
for(i in 1:dim(y)[1]){
tmp<-order(y[,i])
y1[,i]~ y[, tmp[lotrm:hitrm] ]
}
bitmap(file='test2.png')
pairs(t(y))
```

Compute

Summary of computational transaction

Raw Input	view raw input (R code)
Raw Output	view raw output of R engine
Computing time	1 seconds
R Server	'Gwilym Jenkins' @ 72.249.127.135

Boxplot statistics

Variable	lower whisker	lower hinge	median	upper hinge	upper whisker
WJ10AFS	74	86	92	99	114
WJ10AVA	71	82	91	97.5	112
WJ10ARD	69	86	90	99.5	113

Find: SPSS Next Previous Highlight all Match case Reached end of page, continued from top

Done zotero

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CARE Data - Boxplot and Timmed Means - Free Statistics and Forecasting Software (Calculators) v.1.1.23-r4 - Mozilla Firefox

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y1[i,]<- y[i, tmp[lotrm:hitrm]]
}
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Find: SPSS Next Previous Highlight all Match case Reached end of page, continued from top

Done

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- Code is shown and can be modified or re-used in new modules.
- Blogged Analysis reproduced by re-computing.

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if(par3>45){par3<-45;warning('trim limited to 45%')}
if(par3<0){par3<-0;warning('negative trim makes no
sense. Trim is zero.')}
lotrm<-as.integer(length(y[,1])*par3/100)+1
hitrm<-as.integer(length(y[,1])*((100-par3)/100))
y1<-array(dim=c(dim(y)[1], hitrm-lotrm+1),
dimnames=list(dimnames(y)[[1]], 1:(hitrm-lotrm+1) ))
for(i in 1:dim(y)[1]){
tmp<-order(y[,i])
y1[i,]<- y[, tmp[lotrm:hitrm]]
}
bitmap(file='test2.png')
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```

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Find: SPSS Next Previous Highlight all Match case Reached end of page, continued from top

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- Code is shown and can be modified or re-used in new modules.
- Blogged Analysis reproduced by re-computing.
- Changes to analysis computed then blogged.

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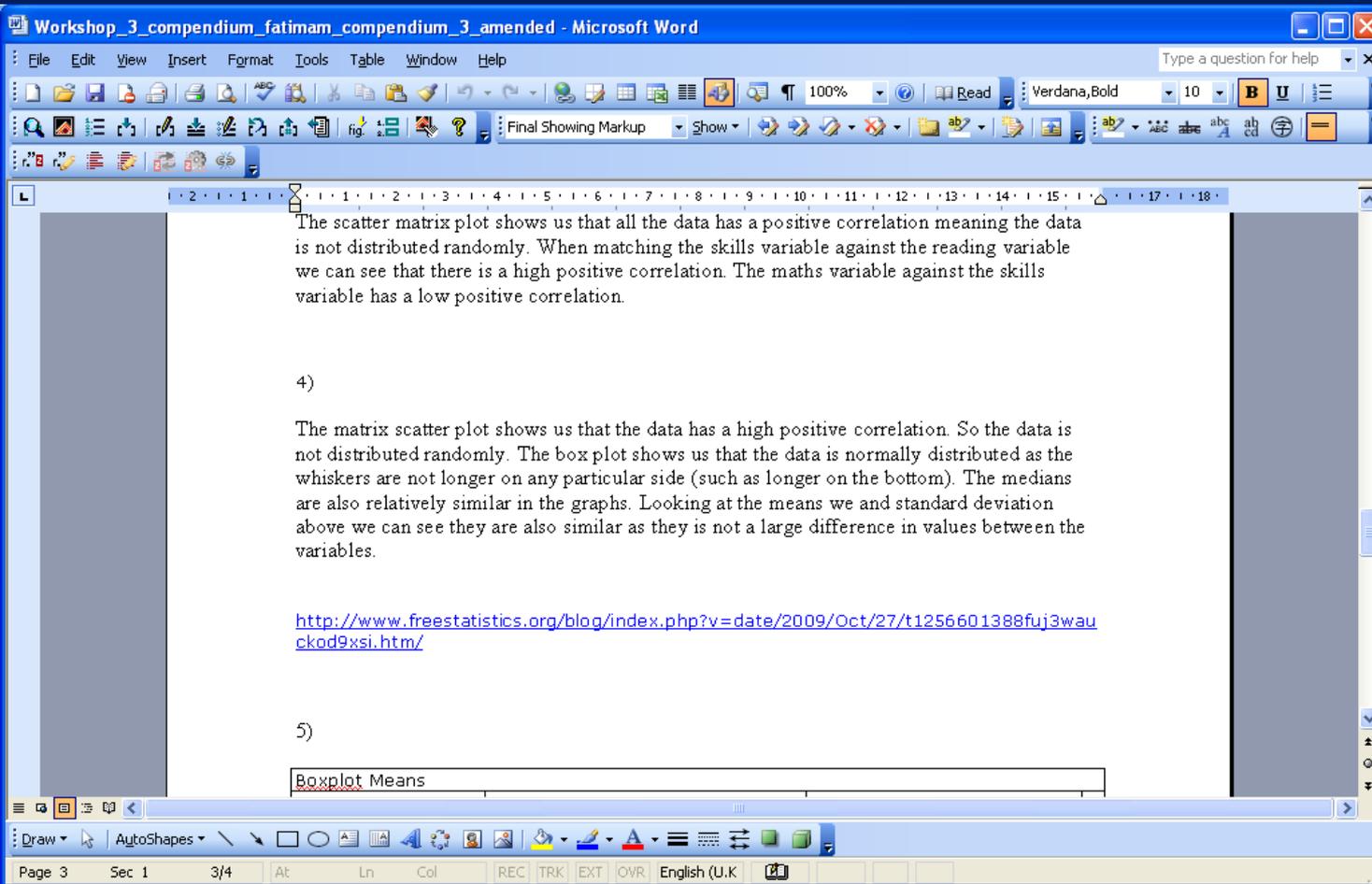
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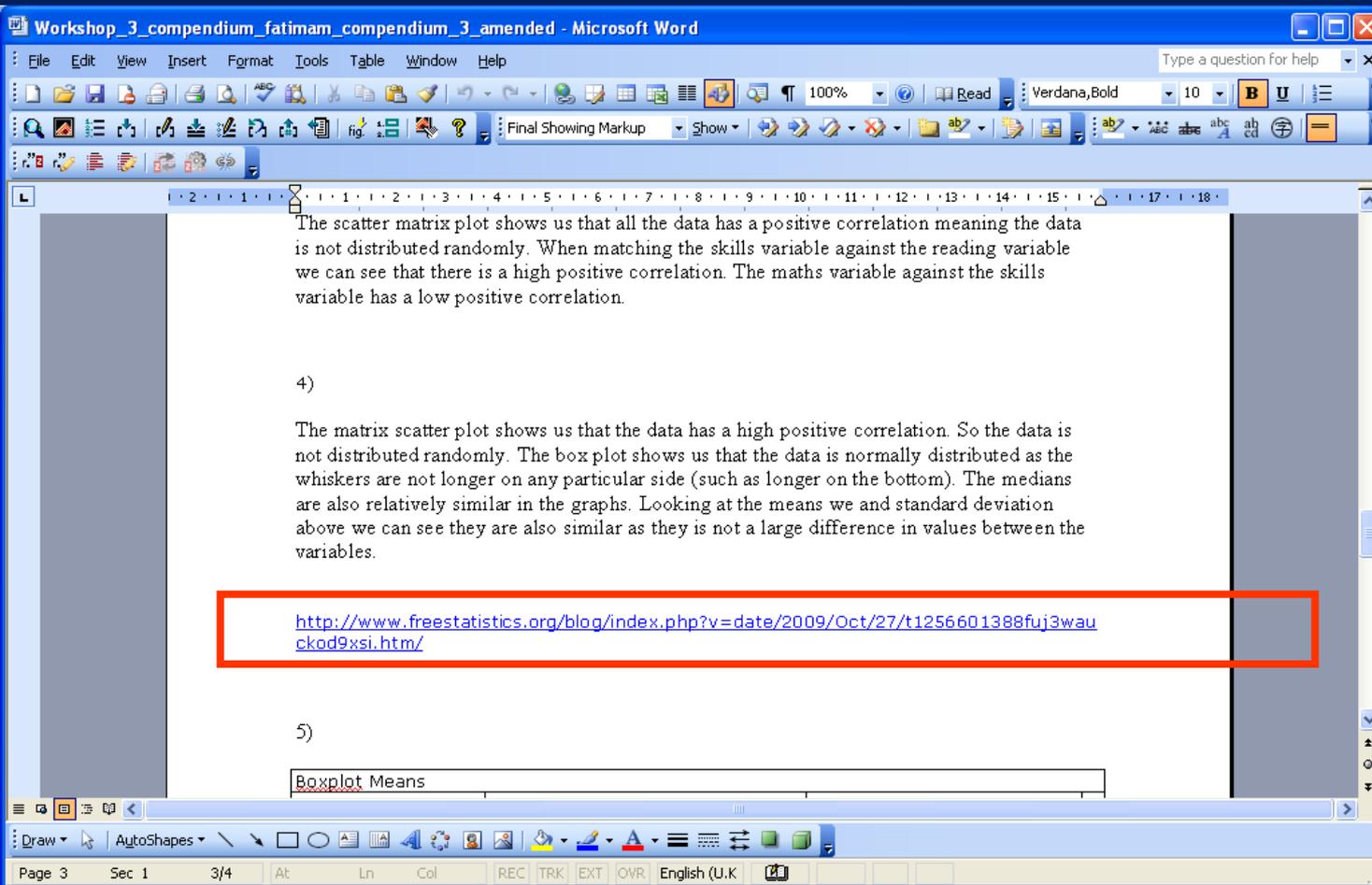
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Student compendium



- Produced in Word or Oo

Student compendium



- Produced in Word or Oo
- Student's provide links to blogs to support stats interpretation

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Peer Review

Click [here](#) to access the Peer Review application.

Surveys:

- Click [here](#) to take the *Attitudes Towards Thinking and Learning Survey*
- Click [here](#) to take the *Academic Motivation Survey*
- CSUQ+ survey (available soon)
- COLLES survey (available soon)

Some notes:

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Reviewing Rubric Guidelines

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Review Deadline Shows in Red

To confirm the announcement at the end of last year regarding the submission reviews for week 11 Patrick

"The deadline for the review about the last workshop was set for 2009-12-22 (my mistake). However, the sy in red but I made sure that this has no impact on the review statistics/reporting whatsoever."

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Here you can view the list of all workshops that your instructors have created for you. Each workshop requires you to: (1) submit a fully Reviews about the Compendia that have been submitted by other students.

Nr.	Workshop Title	Submission Deadline	Submitted	Review Deadline	Reviews submitted
1	Workshop 1	2009-10-13 16:00	yes	2009-10-20 16:00	5/7
Using Histograms & QQplots to graphically investigate sample distributions					
Compendium		Size	Date	Reviews received	Command
Compendium 1		178688	2009-10-19 18:03	4/7	[Details]
ID	Size	Date	Review submitted	Command	
a-082235970	32768	2009-10-12 17:33	2009-10-20 15:17	[Details]	
a-082666705					
a-099033411	152064	2009-10-18 23:31		[Review]	
a-080625555	57344	2009-10-11 13:44	2009-10-20 15:37	[Details]	
a-083415793	74240	2009-10-13 08:35	2009-10-20 15:48	[Details]	
a-081745878	67653	2009-10-12 20:17	2009-10-20 15:59	[Details]	
a-082152183	40448	2009-10-13 10:39	2009-10-20 16:12	[Details]	
Nr.	Workshop Title	Submission Deadline	Submitted	Review Deadline	Reviews submitted
2	Compendium - week 2	2009-10-20 16:00	yes	2009-10-27 16:00	4/7
Assessing Data Quality					
Compendium		Size	Date	Reviews received	Command
Week 2 Compendium		246784	2009-10-20 16:17	5/7	[Details]
ID	Size	Date	Review submitted	Command	
a-082219006	206848	2009-10-19 15:22	2009-10-26 22:21	[Details]	
a-070907856	190464	2009-10-20 13:39	2009-10-26 22:51	[Details]	
a-081836936	147968	2009-10-19 16:43	2009-10-26 23:50	[Details]	
a-099064910	178176	2009-10-29 22:31		[Review]	
a-082235970					
a-083367997					
a-082047915	216576	2009-10-20 13:27	2009-10-27 00:40	[Details]	
Nr.	Workshop Title	Submission Deadline	Submitted	Review Deadline	Reviews submitted
3	Compendium - week 3	2009-10-27 16:00	yes	2009-11-03 16:00	5/7
Carolina educational study dataset (CARE)					
Compendium		Size	Date	Reviews received	Command
Compendium Week 3		274944	2009-10-27 00:58	6/7	[Details]
ID	Size	Date	Review submitted	Command	
a-083507353	132608	2009-10-26 15:59	2009-11-01 23:42	[Details]	

- Student reviews collated and shared anonymously for peer feedback.
- Stats tracked individually

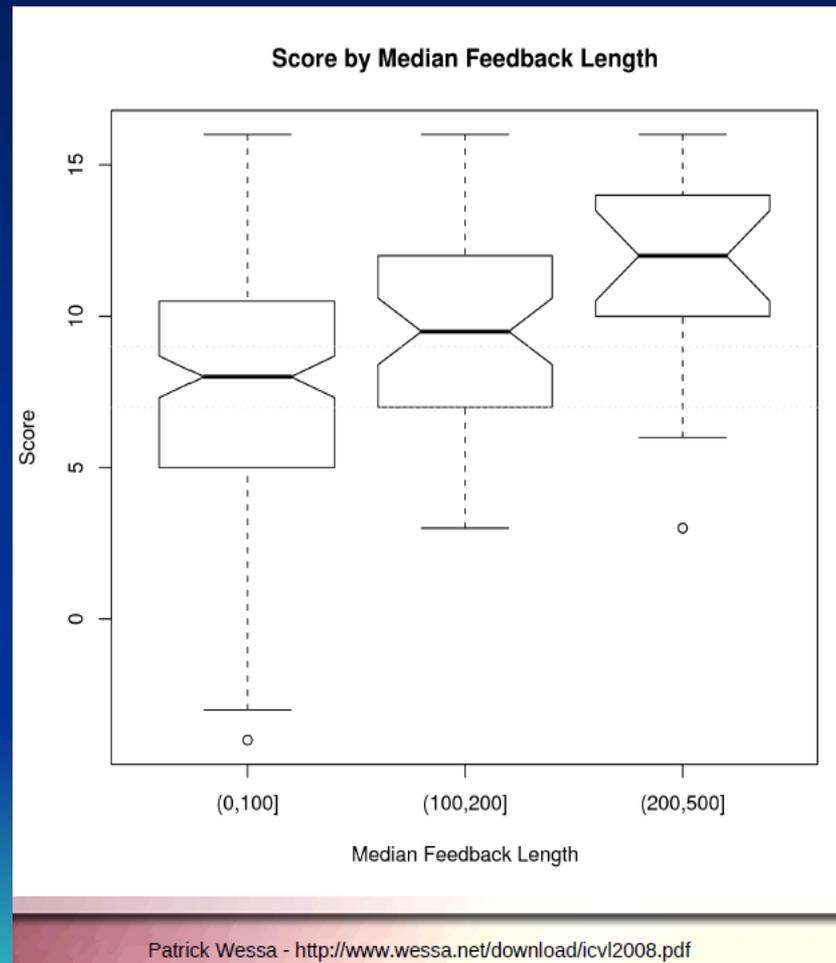
Data captured from students is analyzed within the R framework too.

ID	Median Review Time	Number of Feedback Messages	Feedback Messages per Compendium	Average Feedback Length	Levenshtein per message	Levenshtein per criterion	Messages with Hyperlinks
a-099035389	22	134	3.44	335.12	107.89	60.51	1
a-060610188	7	112	3.29	143.8	68.94	39.05	0
a-081954632	2	92	2.42	88.7	62.41	69.6	0
a-082235970	9	115	3.29	244.97	97.89	53.34	0
a-082666705	13	94	3.13	289.48	87.22	75.79	0
a-099033411	15	137	3.43	276.93	105.38	41.24	1
a-080625555	8	112	3.03	174.31	76.19	48.82	0
a-083415793	8	74	2.47	332.74	104.79	70.21	0
a-081745878	12	101	2.97	268.43	109.41	63.59	0
a-082152183	22	155	4.08	397.95	164.27	116.09	0
a-071330161	10	63	2.17	355.29	98.84	72.67	0
a-081749120	7	110	2.89	135.95	67.68	56.59	0
a-082700353	17	128	3.37	531.25	169.02	129.43	0
a-083205954	21	118	3.37	515.73	189.34	123.26	1
a-099041863	5	132	3.67	197.41	91.1	72.53	0
a-085544789	0	0	0	0	0	0	0
a-083822016	6	68	3.4	124.4	71.46	51.17	0
a-082438124	6	100	3.03	167.91	74.16	56.85	0
a-081276394	6	100	2.78	145.83	77.01	77.74	0
a-081943290	11	97	2.69	257.55	89.04	62.56	0
a-089006164	13	87	2.64	478.66	156.42	71.49	1
a-099010906	7	133	3.33	212.19	78.98	51.86	0
a-081667846	6	96	3.43	176.07	73.2	53.06	0
a-082122441	14	130	3.51	184.32	76.78	67.21	0
a-081997215	15	162	4.05	319	109.44	48.62	0
a-081393613	8	130	2.89	157.64	80.35	69.74	0

- Data captured from students is analyzed within the R framework too.
- This shows per student performance on several metrics e.g. feedback message length

ID	Median Review Time	Number of Feedback Messages	Feedback Messages per Compendium	Average Feedback Length	Levenshtein per message	Levenshtein per criterion	Messages with Hyperlinks
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a-081954632	2	92	2.42	88.7	62.41	69.6	0
a-082235970	9	115	3.29	244.97	97.89	53.34	0
a-082666705	13	94	3.13	289.48	87.22	75.79	0
a-099033411	15	137	3.43	276.93	105.38	41.24	1
a-080625555	8	112	3.03	174.31	76.19	48.82	0
a-083415793	8	74	2.47	332.74	104.79	70.21	0
a-081745878	12	101	2.97	268.43	109.41	63.59	0
a-082152183	22	155	4.08	397.95	164.27	116.09	0
a-071330161	10	63	2.17	355.29	98.84	72.67	0
a-081749120	7	110	2.89	135.95	67.68	56.59	0
a-082700353	17	128	3.37	531.25	169.02	129.43	0
a-083205954	21	118	3.37	515.73	189.34	123.26	1
a-099041863	5	132	3.67	197.41	91.1	72.53	0
a-085544789	0	0	0	0	0	0	0
a-083822016	6	68	3.4	124.4	71.46	51.17	0
a-082438124	6	100	3.03	167.91	74.16	56.85	0
a-081276394	6	100	2.78	145.83	77.01	77.74	0
a-081943290	11	97	2.69	257.55	89.04	62.56	0
a-089006164	13	87	2.64	478.66	156.42	71.49	1
a-099010906	7	133	3.33	212.19	78.98	51.86	0
a-081667846	6	96	3.43	176.07	73.2	53.06	0
a-082122441	14	130	3.51	184.32	76.78	67.21	0
a-081997215	15	162	4.05	319	109.44	48.62	0
a-081393613	8	130	2.89	157.64	80.35	69.74	0

Exam Results and Feedback Effort



Experiment on VLE Design

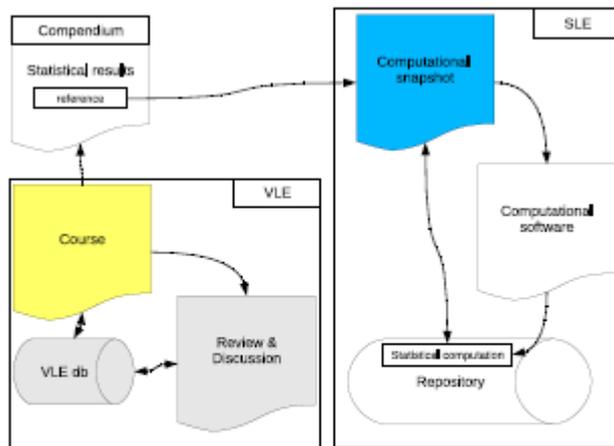


Figure 4. System Design — Year 0

Traditional VLE

Experiment on VLE Design

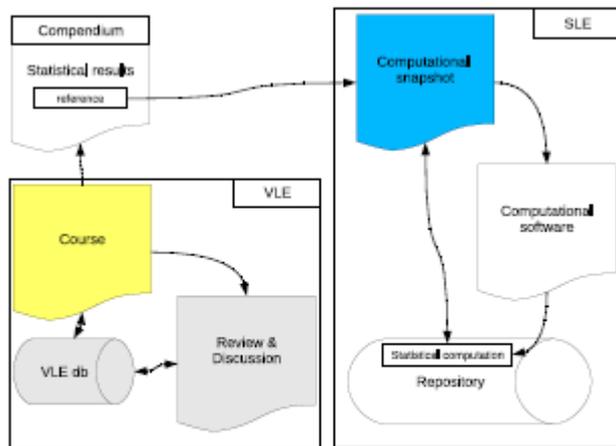


Figure 4. System Design — Year 0

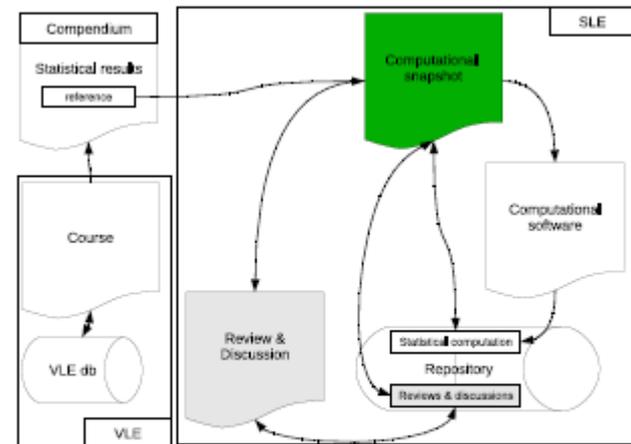


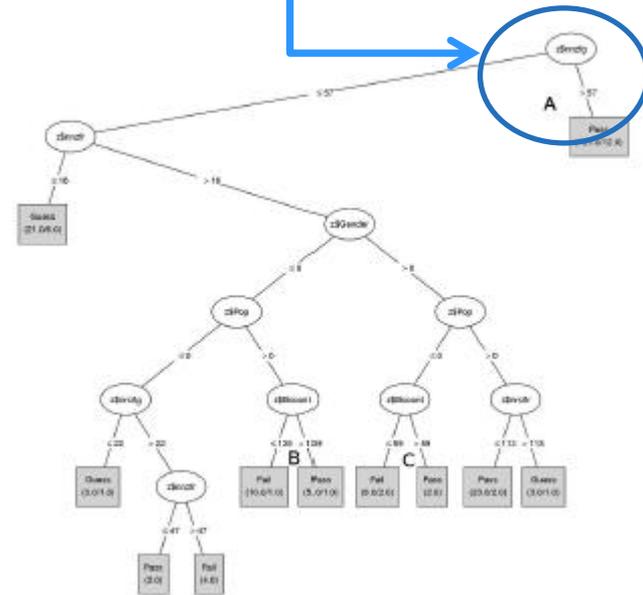
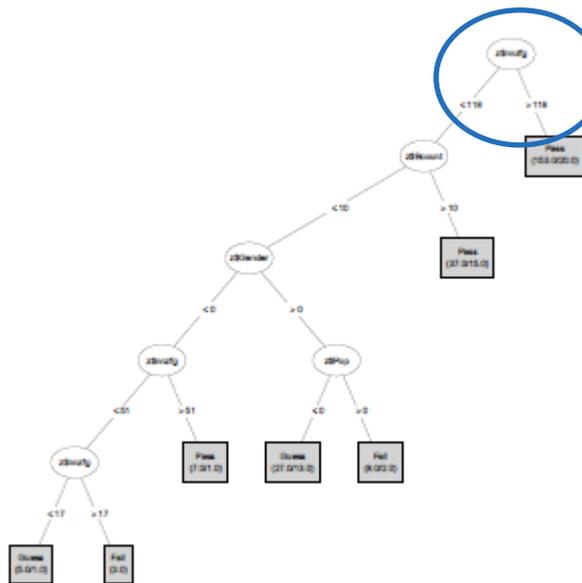
Figure 5. System Design — Year 1

Traditional VLE

Statistical LE

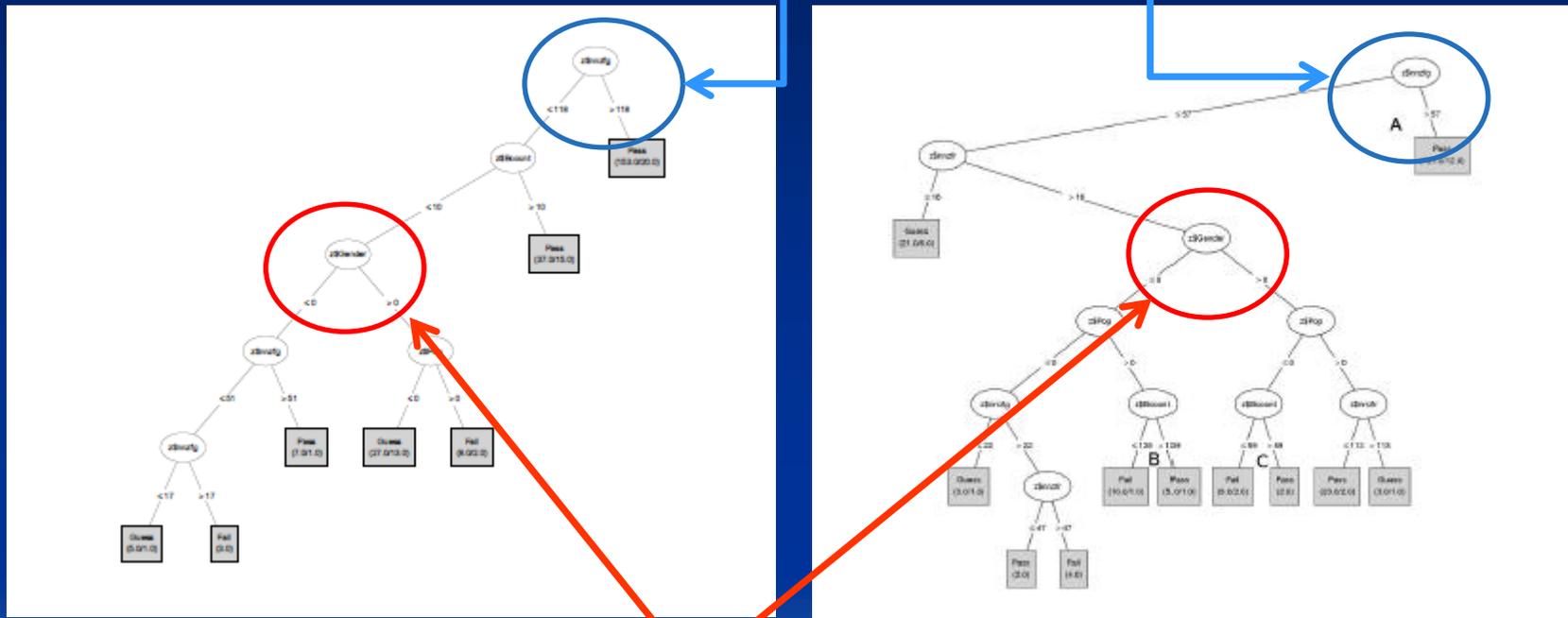
Effect of VLE DDesign

Feedback messages rate is dominant variable: threshold for pass is 118 in year 1 vs. 57 in year 2 -> large increase in efficiency



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A gender bias in year 1 is eliminated in the new design

Issues

- Course development takes a lot of effort
 - But a core of material is now available



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- Student resistance to workload
 - Actually well-matched to course requirement.
- Perceived professional status of SPSS vs. R
 - Point is to learn statistics; open source tools



End of Presentation

